COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

July 1, 1959

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
MATERIALS RESEARCH LABORATORY
132 GRAHAM AVENUE
LEXINGTON 29, KENTUCKY

Ward J. Oates
COMMISSIONER OF HIGHWAYS

S.1.3.4.
D.1.7.

MEMO TO: D. V. Terrell
Director of Research

The attached report, "Progress Report on Calcium Chloride Maintained Traffic-Bound Roads," by George R. Laughlin, contains initial treatment cost records on calcium chloride treated traffic-bound surface roads under study.

You will recall that we were requested to work with the Maintenance Division in evaluating a series of projects that are to be maintained as open traffic-bound surfaces. Maintenance cost of this type treatment is to be compared with normal traffic-bound surface maintenance costs on comparable roads.

One factor that may change the cost structure somewhat of the calcium chloride treated roads is the present trend toward bulk purchases of the material. All of the roads treated to date have used bagged calcium chloride which, of course, is more expensive to apply.

The performance of the test projects is being observed regularly and cost records will be maintained. It is anticipated that 4 or 5 years will be needed to give the proper significance to the evaluation.

Respectfully submitted,

W B Drake

W. B. Drake
Associate Director of Research

WBD:dl
Enc.
cc: Research Committee Members
Bureau of Public Roads

Commonwealth of Kentucky
Department of Highways

# PROGRESS REPORT ON CALCIUM CHLORIDE MAINTAINED TRAFFIC BOUND ROADS

BY

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Highway Materials Research Laboratory
Lexington, Kentucky

May, 1959

# INTRODUCTION

The object of this study is to evaluate the effectiveness of calcium chloride in maintaining traffic-bound roads. Various theses propose that the use of calcium chloride will minimize the loss of granular material from the base by reducing attrition and dusting; thereby aiding in stabilization. Such theses further suggest that when the proper amount of binder or soil mortar is present, calcium chloride will preserve a more uniform moisture condition within the soil-mortar and thus hold the aggregate in place and in a more stable condition. The primary purpose of the study is not to test these theses, but rather to evaluate the practice with respect to currently routine maintenance procedures and their comparative costs.

A maximum of fifty miles of traffic-bound roads were to be programmed for the study. Projects were selected by each maintenance district in cooperation with the Research Division. The initial application of calcium chloride was to be made at the rate of 1.6 lbs. per sq. yd. of the anhydrous material or 2.0 lbs. per sq. yd. of the hydrated material. Thereafter, calcium chloride was to be added twice annually: in the spring, at the rate of 0.8 lbs. per sq. yd, based upon anhydrous material; and in the fall, at the rate of 0.4 lbs. per sq. yd., based upon anhydrous material. Prior to applying the calcium chloride, the surfaces were to be re-shaped and any necessary aggregate and binder added. It was desirable, of course, that this operation be made while the surface was in a moist condition.

Since economic considerations were of primary importance in the study, all surface maintenance cost records on these projects were to be closely evaluated and, insofar as possible, compared with costs of maintaining roads of this type without the use of calcium chloride.

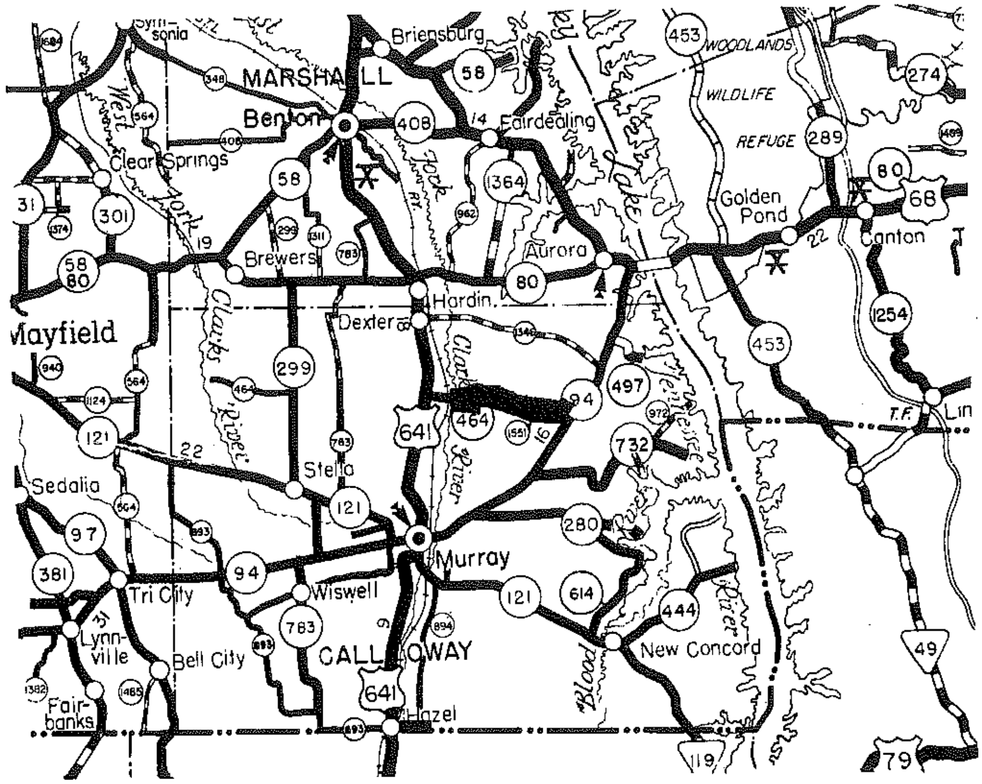



Fig. 1 - District 1, Calloway Co. (Ky. 464) M.P. 018-203-D

| | |
|---|---|
| Date of Acceptance . . | 8-30-58 |
| Width of Base . . . . . . | 18 Ft. |
| Type of Base . . . . . . . | Bank Gravel |
| Length of Project . . . | 6.034 Mi. |
| Stratum . . . . . . . . . . . | Unconsolidated Gravel, Sand and Thin Soil Horizon Developed from Loess |

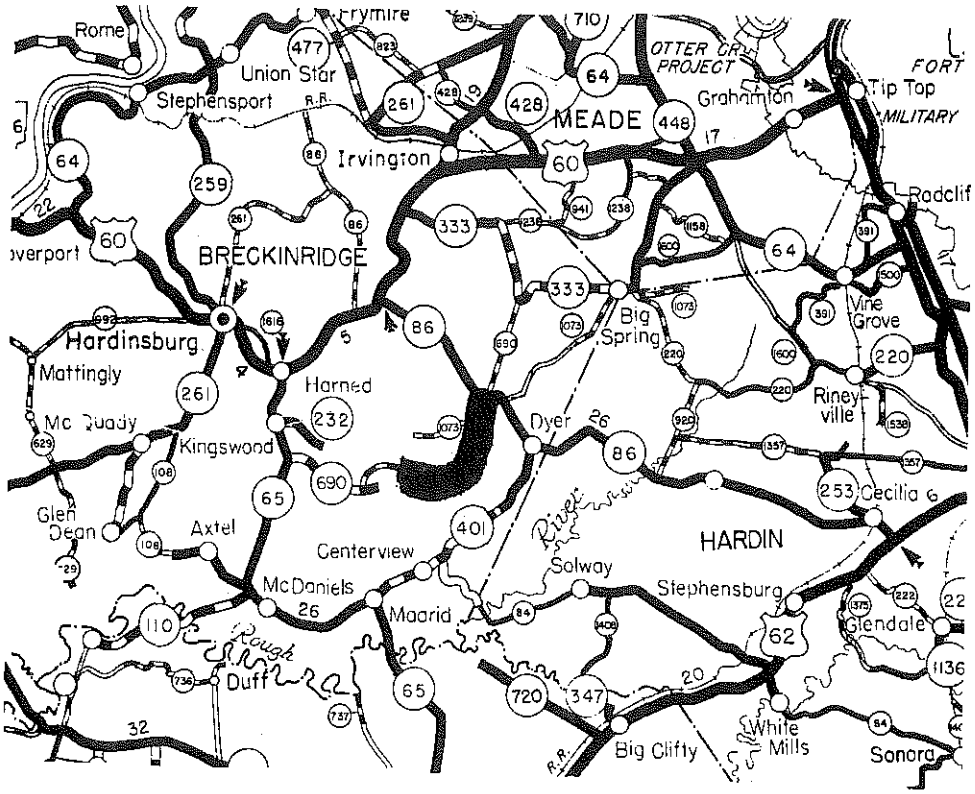



Fig. 2 - District 3, Breckinridge Co. (Ky. 690) MP .014-733-B.

| | |
|---|---|
| Date of Acceptance. . | 1-20-56 |
| Width of Base . . . . . . | .16 Ft. |
| Type of Base . . . . . . . | Crushed Limestone |
| Length of Project . . | 7.000 Mi. |
| Stratum . . . . . . . . . . | Interbedded Limestone, Sandstone and Shale with a Silty Loam Soil Horizon |

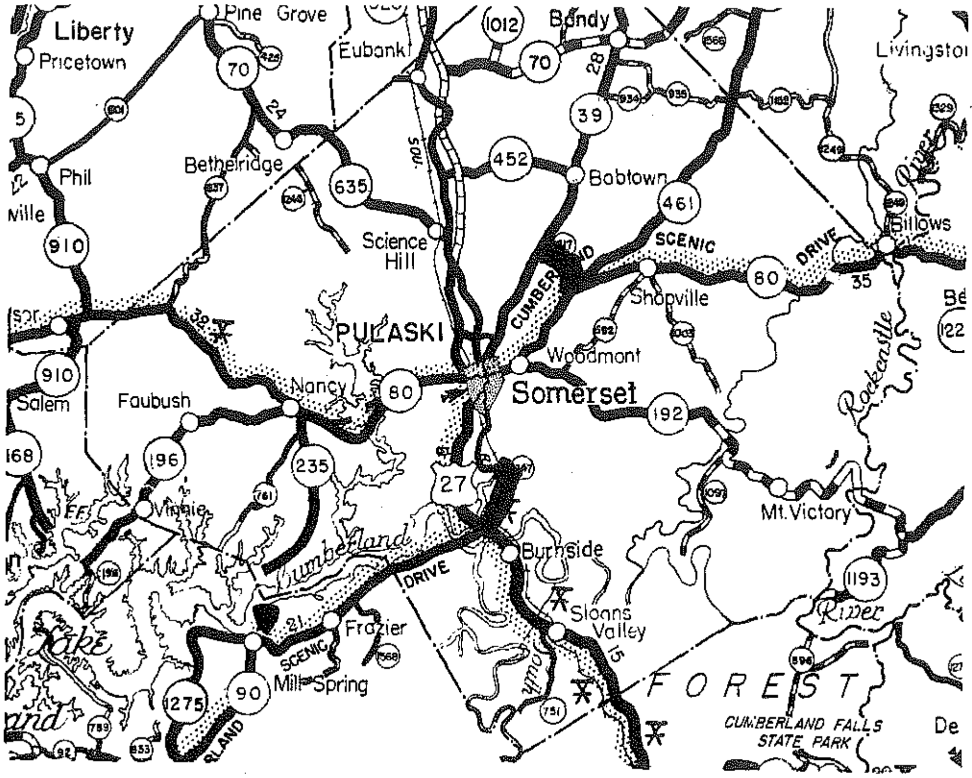



Fig. 3 - District 4, Pulaski Co. (KY. 1317) M.P. 100-25-C.

| | |
|---|---|
| Date of Acceptance . . | 12-12-53 |
| Width of Base . . . . . . | 16 Ft. |
| Type of Base . . . . . . . | Crushed Limestone |
| Length of Project . . | 3.263 Mi. |
| Stratum . . . . . . . . . . . | Massive Limestone, Overlain with Silty Clay Soil Horizon |

District 4, Pulaski Co. (KY. 1247) M. P. 100-885-E

| | |
|---|---|
| Date of Acceptance . . | 10-28-53 |
| Width of Base. . . . . . . | 16 Ft. |
| Type of Base . . . . . . | Crushed Limestone |
| Length of Project . . . | 3.585 Mi. |
| Stratum . . . . . . . . . . . | Massive Limestone Overlain with Silty Clay Soil Horizon |

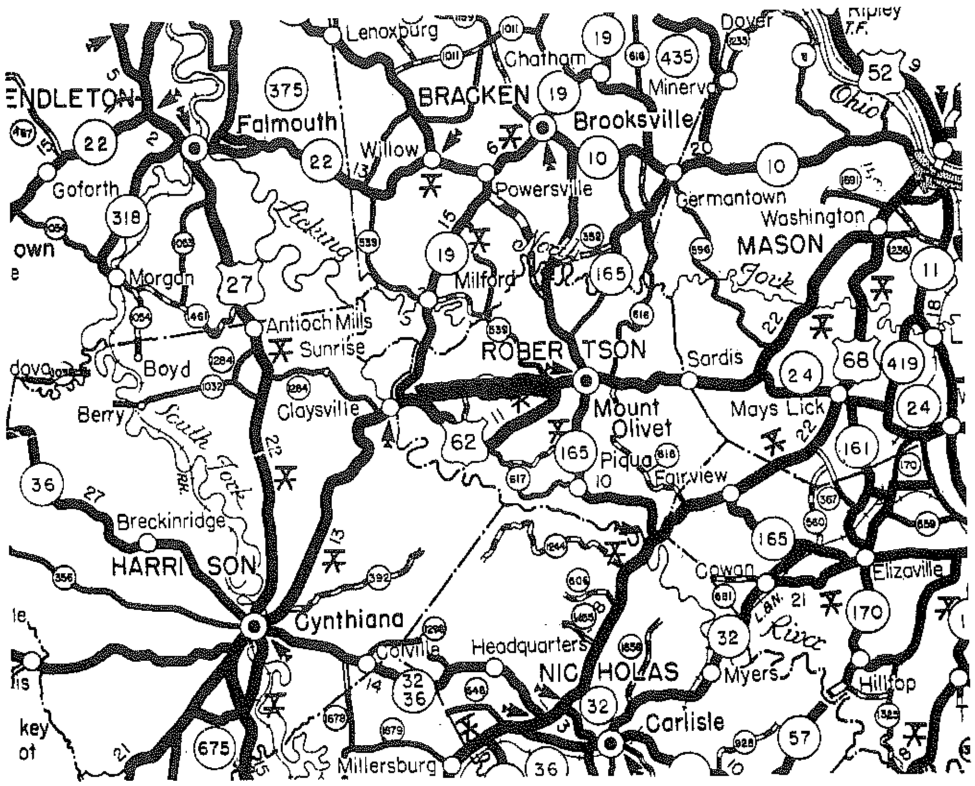



Fig. 4 - District 5, Robertson Co. (KY. 1504) M. P. 101-161-B

| | |
|---|---|
| Date of Acceptance . . | 9-7-54 |
| Width of Base . . . . . . | 18 Ft. |
| Type of Base . . . . . . . | Crushed Limestone |
| Length of Project . . | 6.889 Mi. |
| Stratum . . . . . . . . . . | Interbedded Shale & Limestone Overlain with a Thin Soil Horizon of Clay Loam and Clay |

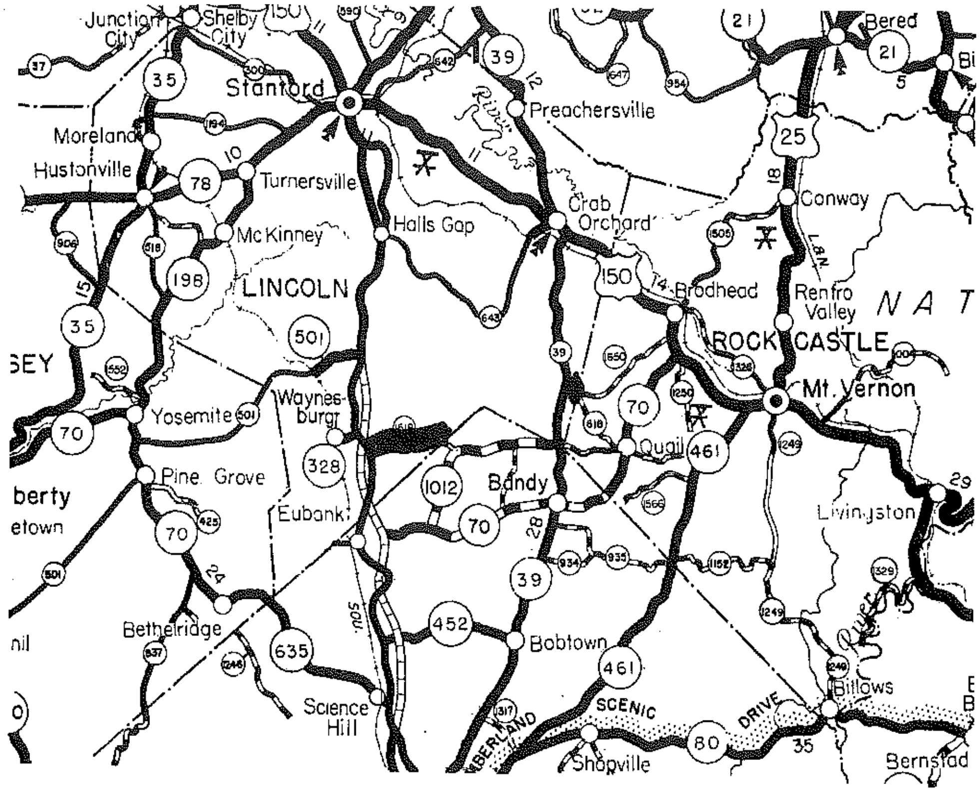



Fig. 5 - District 6, Lincoln Co. (KY. 1518) M. P. 069-450-B

| | |
|---|---|
| Date of Acceptance . . | 11-23-54 |
| Width of Base . . . . . . | 18 Ft. |
| Type of Base . . . . . . | Crushed Limestone |
| Length of Project . . | 4.028 Mi. |
| Stratum . . . . . . . . . . | Cherty Limestone Overlain with a Silty Clay Soil Horizon |

District 6, Lincoln Co. (KY. 618) M. P. 069-510-B

| | |
|---|---|
| Date of Acceptance . . | 9-26-56 |
| Width of Base . . . . . . | 16 Ft. |
| Type of Base . . . . . . | Crushed Limestone |
| Length of Project . . | 1.028 Mi. |
| Stratum . . . . . . . . . . | Cherty Limestone Overlain with a Silty Clay Soil Horizon |

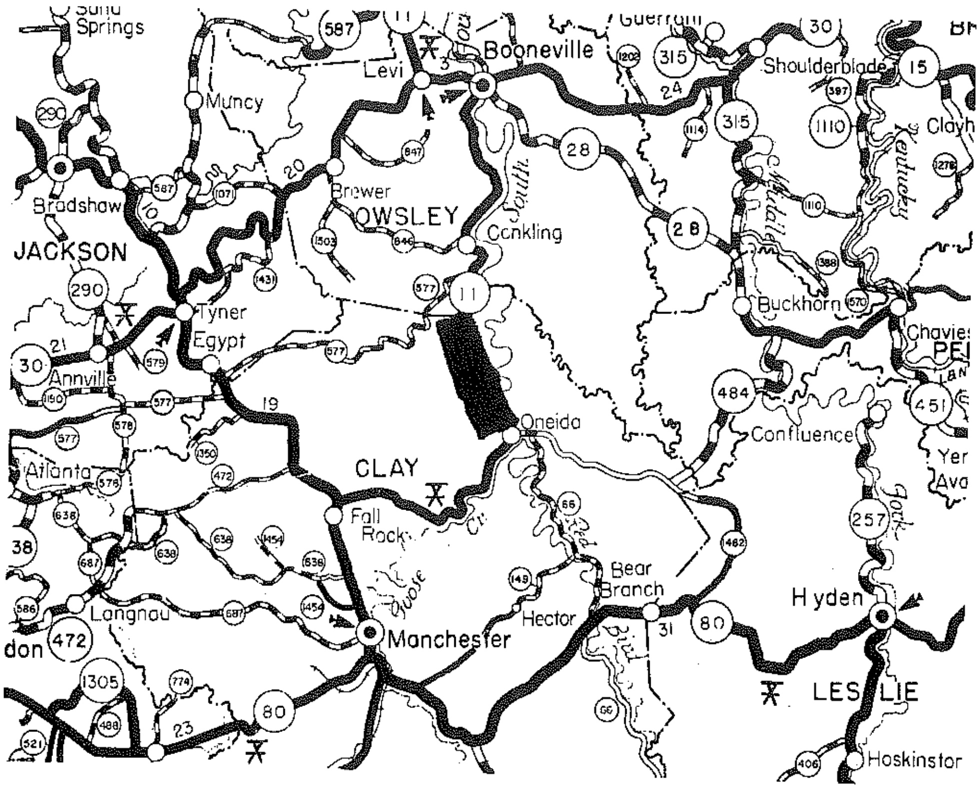



Fig. 6 - District 8, Clay Co. (KY. 11) M. P.
026-25-E

Date of Acceptance . . Fall 1958

Width of Base . . . . . . 18 Ft.

Type of Base . . . . . . Crushed Limestone

Length of Project . . 7.567 Mi.

Stratum . . . . . . . . . . Sandstone and Shale Overlain with a Thin Soil Horizon of Silty Loam

# TREATMENTS WITH CALCIUM CHLORIDE

## Initial Treatments

In the fall of 1958, seven projects were initially treated. An eighth project was treated in April 1959. To date, 39.394 miles of traffic bound roads have been initially treated. Preparation of the road surfaces were kept to a minimum. Most of the preparatory operations consisted of re-shaping of the crown and adding binder material from the shoulders. The calcium chloride was delivered from warehouses to the job sites in bags where it was loaded on the spreaders for application. In all instances, the calcium chloride went into solution within 24 hours after application.

## Seasonal Treatments

To date spring treatments have been made on several projects. In District 5, bag-material was used. The preparation of the surface consisted of reshaping the crown and pulling in aggregate stored on the shoulders. The calcium chloride was applied at the rate of 0.8 lbs. per sq. yd. In District 4, the crowns were reshaped with addition of aggregate where needed. Bulk material was applied with Swenson spreaders. The application rate was 0.8 lbs. per sq. yd. In District 6, bulk calcium chloride was applied with Shunk and Highway spreaders. The application rate was 1.2 lbs. per sq. yd. Treatment was made with an excess of floater on the surface.

## Equipment

Various types of spreaders have been used in applying the calcium chloride: lime drill, Champion, Highway, Shunk, Gibbs and Swenson. The Buckeye spreader has not been used as yet. Of those used, the Champion was unsatisfactory, while the others may be classed as giving fair satisfaction. The Shunk spreader gave the most even application (See following figures of equipment).

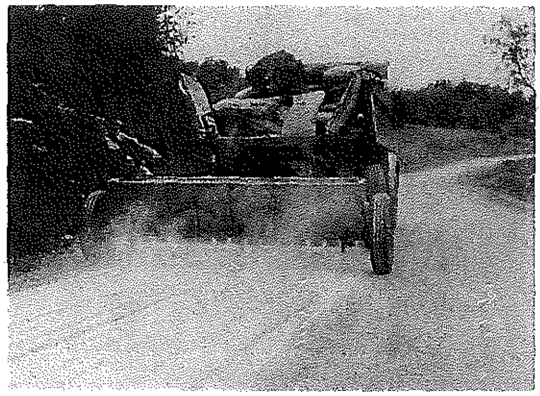


Fig. 7 - Lime Drill in Operation Uneven Application.

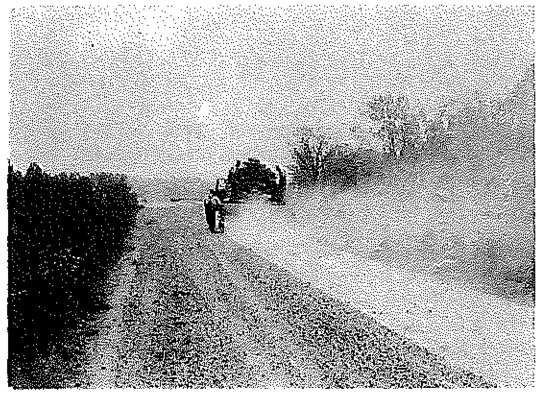


Fig. 8 - Champion Spreader in Operation, Excessive Application .

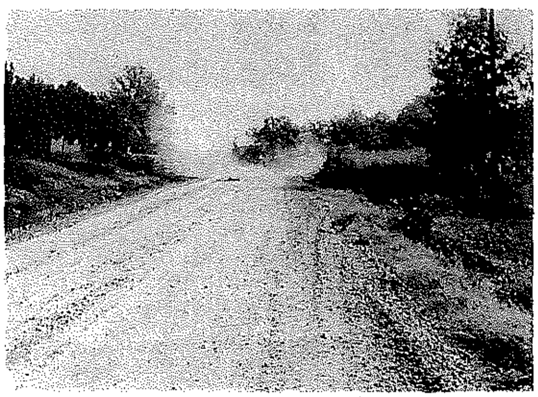


Fig. 9 - Highway Spreader in Operation, Even Application.

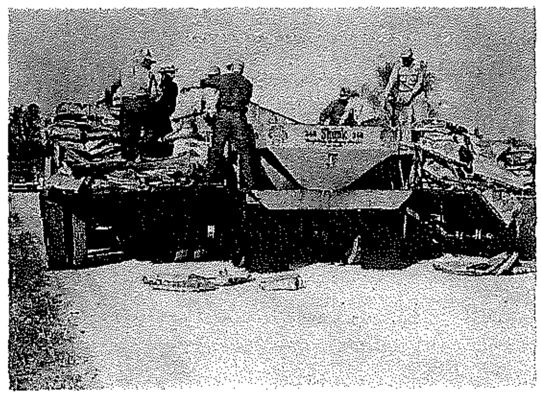


Fig. 10 - Shunk Spreader in Operation, even Application.

Fig. 11 - Gibbs Spreader in Operation, Uneven Application.

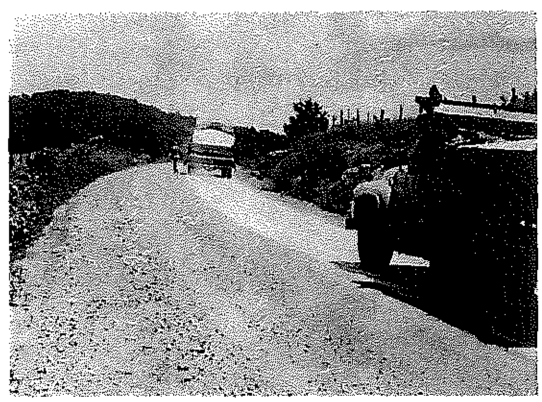


Fig. 12 - Swenson Spreader in Operation, Uneven Application.

## PERFORMANCE OF PROJECTS SINCE INITIAL TREATMENT

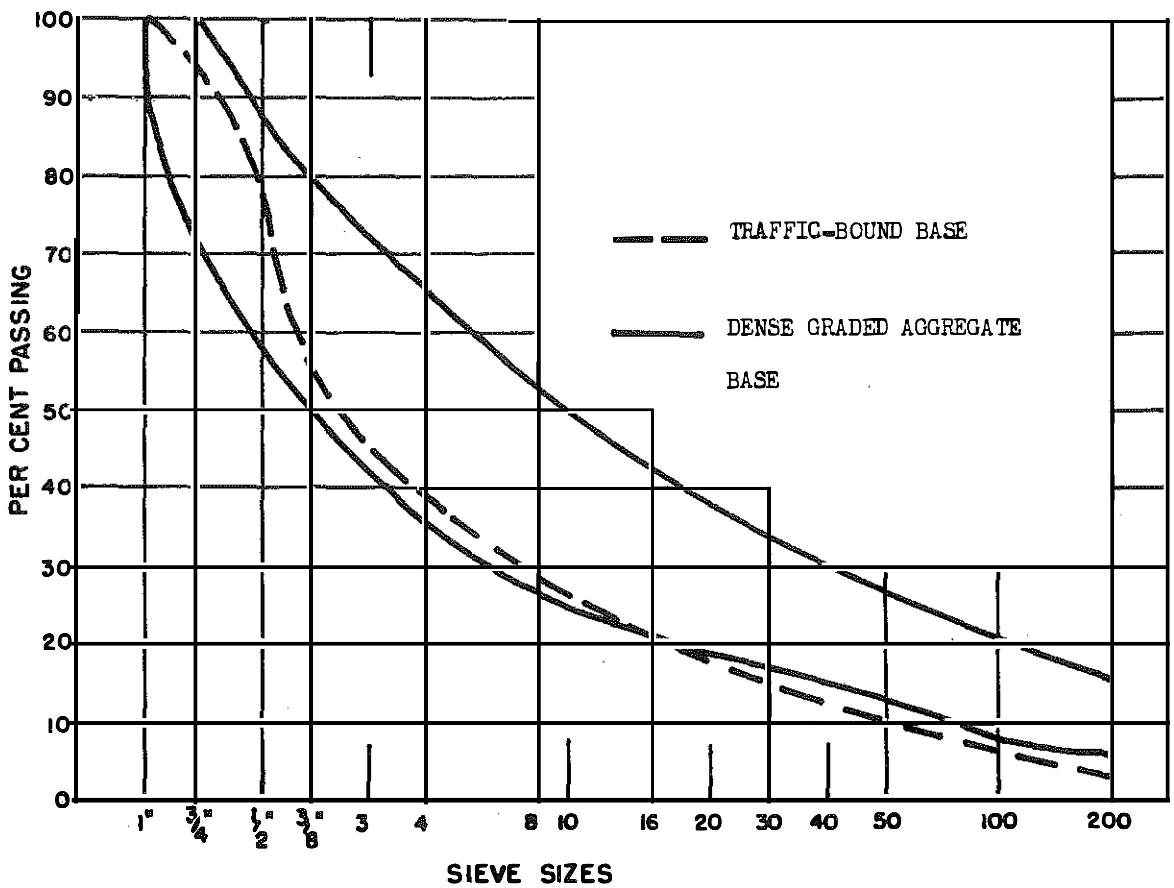
The traffic-bound bases of the projects initially treated in the fall of 1958, generally remained stable and retained their crowns until late in the winter season. An exception was M.P. 014-733-B in District 3. This base has remained in an unstable condition throughout the winter and spring seasons. The performance of the base of M.P. 101-161-B in District 5 was very satisfactory. From the initial treatment to the spring treatment, maintenance was performed only on flat tangents where chuckholes formed.

During regular inspections of the projects the thickness of the traffic-bound bases were measured. Table 1 shows the base thickness of each project as measured in the traffic lanes.

A gradation analysis of the base material was performed on each project under study. The graph included here as page 14 shows the gradation of base material from one project in comparison with dense-graded aggregate base currently in use.

Table 1 - Base Thickness of Traffic-Bound Roads, April, 1959.

| | Base Thickness of Project in Inches | | | |
|---|---|---|---|---|
| Project No. | Beginning | Middle | End | Average |
| M.P. 018-203-D | 4.50 | 4.25 | 4.25 | 4.33 |
| M.P. 014-733-B | 1.00 | 1.00 | 0.75 | 0.92 |
| M.P. 100-25-C | 3.50 | 0.50 | 1.50 | 1.83 |
| M.P. 100-855-E | 0.75 | 0.75 | 1.00 | 0.83 |
| M.P. 101-161-B | 1.25 | 0.75 | 3.50 | 1.83 |
| M.P. 069-450-B | 0.50 | 4.50 | 4.50 | 3.17 |
| M.P. 069-510-B | 4.50 | 4.50 | 4.50 | 4.50 |




Gradation of Traffic-Bound Macadam Base Sampled from M.P. 101-161-B and Gradation of Dense-Graded Aggregate Base.

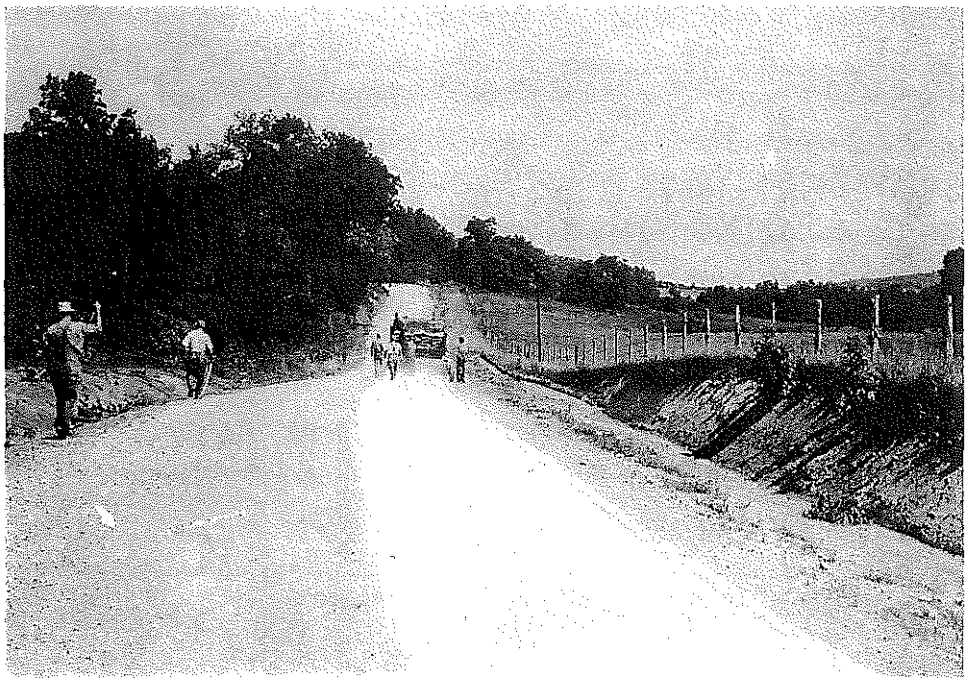


Fig. 13 - M.P. 100-25-C, Initial Application in August, 1958.

Fig. 14 - M.P. 100-25-C, Result of Sufficient Binder and High Crown, April, 1959.

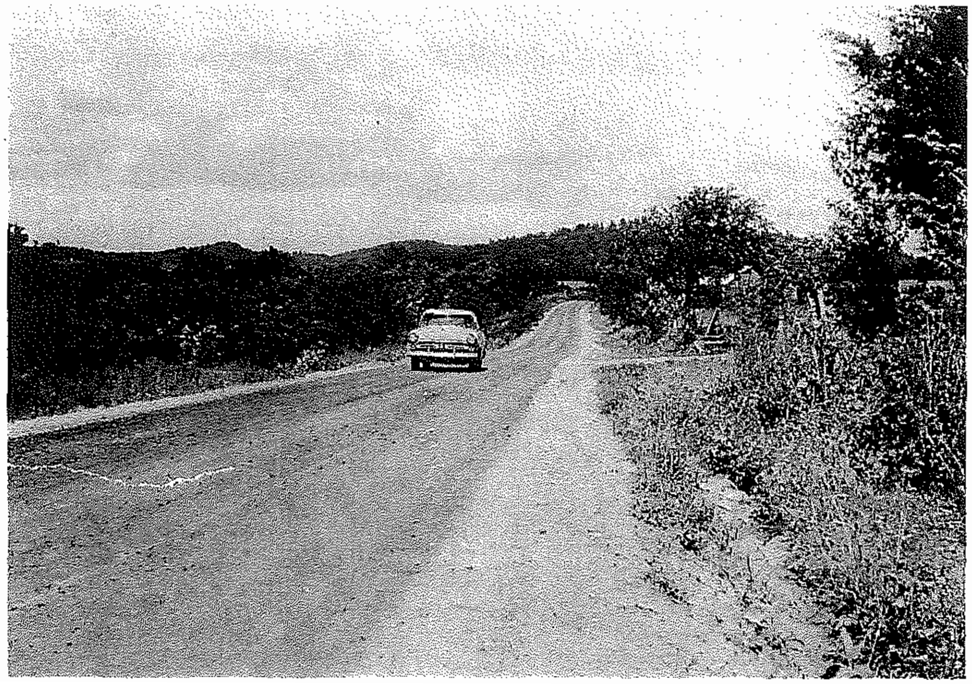


Fig. 15 - M.P. 100-855-E, Absence of Crown, August, 1958.

Fig. 16 - M.P. 100-855-E, Result of Absence of Crown, April, 1959.

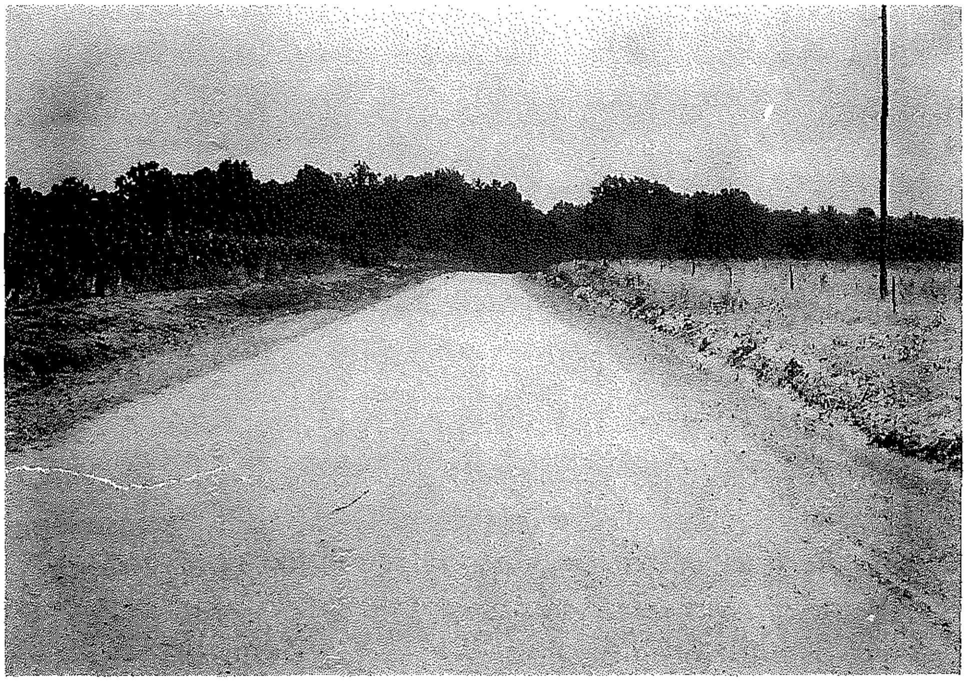


Fig. 17 - M.P. 069-450-B,Prior to Initial Treatment.

Fig. 18 - M.P. 069-450-B, Excessive Metal Which Can Not be Tied Down, April, 1959.

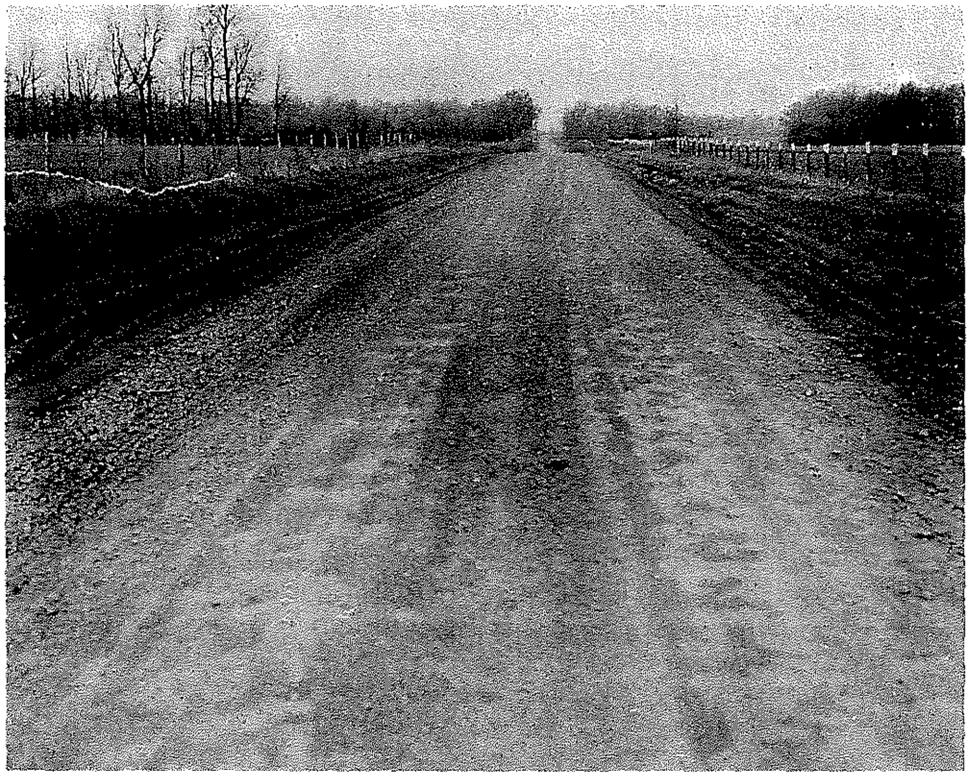


Fig. 19 - M. P. 018-203-D, Secondary Ditches, April, 1959.

## COSTS

### Initial Treatment Costs

The cost of the initial treatment program, thus far, as reported by each maintenance district is as follows:

Table 2 - Cost of Initial Treatment Program

| Item | Cost |
|---|---|
| Calcium Chloride | $17,256.98 |
| Equipment | 1,957.54 |
| Labor | 3,275.40 |
| Total | $22,489.92 |
| Cost per mile | $ 570.90 |

Table 3 gives the cost of initial treatment of each project.

### Maintenance Cost Since Initial Treatment

Since initial treatment, maintenance costs have been reported each month on the above mentioned maintenance projects. These are shown in Table 4.

### Comparison Road Costs

Traffic-bound macadam roads located close to the projects under study were selected for comparative analysis. Where suitable projects were not available, the projects under study were used, the costs being taken prior to treatment with calcium chloride. Maintenance costs of these operations during the Fiscal Year 1957-58 are listed in Table 5. These costs are taken from the General Ledger (Form MR-2).

Table 3 - Cost of Initial Treatments

| Project | Calcium Chloride | Equipment | Labor | Total Cost | Cost Per Mi. |
|---|---|---|---|---|---|
| District 1 Calloway Co. (Ky. 464) M.P. 018-203-D | $2,490.00 | $431.50 | $542.96 | $3,464.49 | $574.10 |
| District 3 Breckinridge Co. (Ky. 690) M.P. 014-733-B | 2,450.80 | 343.78 | 492.70 | 3,287.28 | 469.61 |
| District 4 Pulaski Co. (Ky. 1317) M.P. 100-25-C | 1,501.18 | 162.63 | 224.46 | 1,888.27 | 578.69 |
| District 4 Pulaski Co. (Ky. 1247) M.P. 100-855-E | 1,387.00 | 125.20 | 316.50 | 1,828.70 | 510.09 |
| District 5 Robertson Co. (Ky. 1504) M.P. 101-161-B | 3,946.50 | 367.69 | 1,268.58 | 5,582.77 | 810.28 |
| District 6 Lincoln Co. (Ky. 1518) M.P. 069-450-B | 2,243.00 | 265.13 | 154.00 | 2,662.13 | 660.90 |
| District 6 Lincoln Co. (Ky. 618) M.P. 069-510-B | 753.00 | 128.81 | 154.00 | 1,035.81 | 1,007.60 |
| District 8 Clay Co. (Ky. 11) M.P. 026-25-E | 2,486.00 | 132.80 | 276.20 | 2,895.00 | 408.03 |

Table 4 - Maintenance Costs Since Initial Treatment

| Project | Date | Type of Maintenance | Cost Item: Material | Cost Item: Equipment | Cost Item: Labor | Total | Cost per Mi. per Mo. |
|---|---|---|---|---|---|---|---|
| District 1 | November, 1958 | None | | | | | |
| Calloway Co. | December, 1958 | Replacement Stone (Bank Gravel) | $ 0.00 | $ 68.00 | $ 30.40 | $ 98.40 | |
| (Ky. 464) | January, 1959 | None | | | | | |
| M.P. 018-203-D | February, 1959 | None | | | | | |
| | March, 1959 | Grading Operations | 0.00 | 34.00 | 15.20 | 49.20 | |
| | April, 1959 | Grading Operations | 0.00 | 68.00 | 30.40 | 98.40 | 6.79 |
| District 3 | October, 1958 | Grading Operations | 0.00 | 34.00 | 15.20 | 49.20 | |
| Breckinridge Co. | November, 1958 | Grading Operations | 0.00 | 68.00 | 30.40 | 98.40 | |
| (Ky. 690) | December, 1958 | Grading Operations | 0.00 | 68.00 | 30.40 | 98.40 | |
| M.P. 014-733-B | January, 1959 | Replacement Stone (700 tons No. 610) | 1,799.00 | 0.00 | 38.70 | 1,837.70 | 656.31 |
| District 4 | September, 1958 | None | | | | | |
| Pulaski Co. | October, 1958 | None | | | | | |
| (Ky. 1317) | November, 1958 | None | | | | | |
| M.P. 100-25-C | December, 1958 | None | | | | | |
| | January, 1959 | Replacement Stone & Grading Oper. (176.43 tons No. 610) | 264.65 | 69.32 | 69.12 | 403.09 | 24.71 |
| District 4 | September, 1958 | None | | | | | |
| Pulaski Co. | October, 1958 | None | | | | | |
| (Ky. 1247) | November, 1958 | None | | | | | |
| M.P. 100-855-C | December, 1958 | None | | | | | |
| | January, 1959 | Grading Oper. & Replacement Stone (129.80 tons No. 610) | 194.81 | 57.95 | 86.88 | 339.64 | 18.95 |
| District 5 | October, 1958 | None | | | | | |
| Robertson Co. | November, 1958 | Not Reported | 0.00 | 19.00 | 142.59 | 161.59 | |
| (Ky. 1504) | December, 1958 | Not Reported | 0.00 | 22.85 | 275.82 | 298.07 | |
| M.P. 101-161-B | January, 1959 | Not Reported | 0.00 | 4.05 | 74.34 | 78.39 | 19.54 |
| District 6* | October, 1958 | None | | | | | |
| Lincoln Co. | November, 1958 | None | | | | | |
| (Ky. 1518) | December, 1958 | None | | | | | |
| M.P. 069-450-B | January, 1959 | None | | | | | |
| | February, 1959 | None | | | | | |
| District 6* | October, 1958 | None | | | | | |
| Lincoln Co. | November, 1958 | None | | | | | |
| (Ky. 618) | December, 1958 | None | | | | | |
| M.P. 069-510-B | January, 1959 | None | | | | | |
| | February, 1959 | None | | | | | |

* Costs Taken from the General Ledger (Form MR-2)

Table 5 - Cost of Surface Operations on Comparison Roads 1957-1958.

| Project | Material | Equipment | Labor | Total |
|---|---|---|---|---|
| District 1 | $ 00.00 | $ 360.84 | $ 125.38 | $ 486.22 |
| Calloway Co. | | | | |
| (Ky. 1551) | | | | |
| M.P. 018-623-A | Cost per Mi. per Mo. = $29.17 | | | |
| District 3 | 1,113.00 | 419.17 | 93.68 | 1,625.85 |
| Breckinridge Co. | | | | |
| (Ky. 690) | (475 tons No. 310 Stone) | | | |
| M.P. 014-513-A | Cost per Mi. per Mo. = $29.98 | | | |
| District 4 | 720.00 | 1,367.99 | 169.99 | 2,257.98 |
| Pulaski Co. | | | | |
| (Ky. 1012) | (600 tons No. 6 Stone) | | | |
| M.P. 100-615-A | Cost per Mi. per Mo. = $19.00 | | | |
| District 5 | 1,769.08 | 343.50 | 109.87 | 2,222.45 |
| Robertson Co. | | | | |
| (Ky. 1521) | (558 tons No. 610 Stone) | | | |
| M.P. 101-201-A | Cost per Mi. per Mo. = $81.23 | | | |
| District 6 | 2,925.00 | 2,031.14 | 1,584.30 | 6,540.44 |
| Lincoln Co. | | | | |
| (Ky. 1518) | (1,950 tons No. 610 & No. 6 Stone) | | | |
| M.P. 069-450-A | Cost per Mi. per Mo. = $135.31) | | | |
| District 8 | 1,665.00 | 00.00 | 00.00 | 00.00 |
| Clay Co. | | | | |
| (Ky. 577) | (500 tons No. 6 Stone) | | | |
| M. P. 26-145-B | Cost per Mi. per Mo. = $33.78 | | | |

## SUMMARY

The use of larger quantities of calcium chloride may warrant the purchase of bulk material. When shipped in bulk, calcium chloride should cost about $7.20 a ton less than the bag lots. When using bagged material in the initial treatment for these projects, each bag was handled by laborers four times, with the exception of M. P. 026-25-E in which the material was handled by laborers three times. By using bulk material and mechanical loaders, the cost of application may be reduced.

The graph on page 14 shows the similarity in gradation for dense-graded aggregate base and traffic-bound surface from the Robertson County project. The use of dense-graded aggregate base on traffic-bound roads maintained with calcium chloride would require less soil binder.

From regular inspections of the test projects, the roadway surfaces that have fared the best were those having high crowns and good surface drainage. In every case where there was an absence of crown the surface had chuckholes.

To minimize the loss of granular material, the surface should remain in a moist condition to prevent dusting and raveling during dry seasons and remain in a stable condition during the winter and spring seasons. Maintenance records on traffic-bound surfaced roads indicate that most of the aggregate replacement has been during the winter and spring seasons. Of course, the subgrade is then at its weakest condition, and the lack of adequate granular thickness is often most evident at that time.